

Arterial Embolism

An Analysis of 115 Surgical Procedures

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SUMMARY

Arterial embolus is usually a serious complication of rheumatic or atherosclerotic heart disease. One hundred-fifteen surgical procedures performed in 86 patients with arterial emboli in a 10 years' period in the Department of Adult Thoracic and Cardiovascular Surgery of our university are analyzed regarding the etiology, the treatment, and the results of this complication. Most of the patients were delayed cases showing mild to severe degrees of trophic, sensory and motor disturbances in the limbs without gangrene. These cases are also subjected to vascular surgery (removal of the embolus) as a chance to enable them to use their extremities in lieu of prostheses even when motor and sensory changes persist.

Additional Indexing Words:

Amputation Anticoagulation Arterial embolism Embolectomy
Intracardiac thrombi Revascularization syndrome

ACUTE arterial embolism caused by various materials is a life threatening phenomenon in most of the patients. Majority of these cases are candidates for surgical intervention, although some are managed only by medical treatment.

MATERIAL AND METHODS

Eighty-six patients underwent 115 surgical procedures between years 1964 and 1974. Forty-two patients were males and 44 females; mean age being 53, changing between 27 and 81, excluding the patient who was 14 years old, having bullet embolism in the pulmonary artery.¹⁾

Twenty-three patients (26.7%) were admitted to our clinic within the first 12 hours following the accident. Sixty-three patients (73.3%) were delayed cases showing mild to severe degrees of sensory and motor impairment of the extremity. Etiology and localizations of the emboli are tabulated in Tables I and II. Atrial fibrillation was present in 41 cases (47.6%). Thirty-three patients showed ad-

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Table I. Etiology in 86 Cases

	No. of cases
Mitral stenosis with/without insufficiency	35*
Atherosclerosis	23
Myocardial infarction	13
Not clear	5
Cardiac failure	4
Mitral valve replacement	2**
Aortic valve replacement and open mitral commissurotomy	2**
Aortography (in atherosclerosis)	1
Bullet in the inferior vena cava	1

* Three cases displayed additional aortic stenosis and insufficiency.

** Artificial heart valves were used in the replacements.

Table II. Localizations of Arterial Emboli

	Right	Left	Bilateral
A. Brachialis	7	2	—
A. Axillaris	3	1	—
A. Iliaca externa	6	8*	8
A. Femoralis	13*	22*	13
A. Poplitea	3	8*	—
A. Pulmonalis	1	—	—

* Recurrent embolus occurred in 1 case (totally 4 cases).

ditional pathologies (cerebral emboli: 16, diabetes mellitus: 6, hypertension: 6, mesenteric emboli: 2, cor pulmonale: 1, Addison's disease: 1, hyperthyroidism: 1). Multiple emboli occurred in 32 cases (37.2%).

Embolectomy with Fogarty's catheter was performed in 85 cases. Arteriotomy incision was closed after the irrigation of the distal portion of the artery with xylocaine-like agents (Citanest) and heparinized 0.9% saline solution. Proximal part of the artery was irrigated only with heparinized saline solution. In one of these patients arteriotomy was closed with saphenous vein patch and in another one resection and end-to-end anastomosis of the femoral artery was performed. Right upper lobectomy was done in the patient with bullet embolism from the inferior vena cava to the right pulmonary artery.¹⁾

As additional operations to embolectomy lumbar sympathectomy was performed in 2 cases and thoracal sympathectomy in 1.

Patients undergoing peripheral arterial embolectomy were anticoagulated with heparine during the operation and then by oral anticoagulants (warfarin sodium-coumadin) for a period of 1 month in the presence of only vascular pathology and continuously in emboli secondary to cardiac pathologies. In the first 2 days of the postoperative period 50 and 75 mg of heparine was also given by intravenous injection in every 6 hours intermittently. 500 ml of low molecular weight dextran (Rhemomacrodex) and vasodilators were also infused daily for a period of 5 to 7 days.

RESULTS

Sixty-eight (79.1%) displayed satisfactory results concerning arterial embolus. Fourteen patients (16.3%) underwent amputations. Totally 16 cases (18.6%) expired, 12 of whom displaying satisfactory peripheral arterial patency postoperatively. Four patients (4.6%) died of acute massive ischemia of the extremity and revascularization syndrome. Twelve deaths were due to: cerebral emboli in 3 cases, myocardial infarction in 2 cases, cardiac failure in 2 cases, gastrointestinal hemorrhage in 1, gastrointestinal hemorrhage and diabetic coma in 1, mesenteric emboli and acute abdomen in 1, renal insufficiency in 1, and exitus during amputation in 1 case.

Revascularization syndrome developing postoperatively in 1 patient was treated by peritoneal dialysis.

Ten patients were subjected to radical operations after embolectomy (open mitral commissurotomy: 5, mitral valve replacement: 4, and aortic valve replacement and open mitral commissurotomy: 1). Thrombus was found in the left auricle only in 1 case.

DISCUSSION

Arterial embolism is caused by several materials such as air, fat, foreign bodies, cardiac tumors, cardiac echinococcosis, fragments of artificial heart valves, and thrombosis of various origin (Table III).¹⁾⁻¹²⁾

Thrombus is the most common cause of arterial embolism, being present in the left auricle and atrium in the majority of the patients with mitral stenosis and atrial fibrillation. Heberer et al³⁾ reviewed 1,061 cases in the literature and found the following incidence concerning cardiac thrombus: rheumatic valvulopathy 51%, myocardial infarction 22%, arteriosclerosis 14%, endocarditis 3%. Thrombi in the systemic venous system may seldomly lead to systemic arterial embolism through a right to left shunt like interatrial communication, ventricular septal defect and patent ductus arteriosus (paradoxical embolism). One hundred and seventeen such cases, 110 of them being diagnosed at necropsy, have been reported up to 1970.¹²⁾

Embolism occurs commonly to cerebral arteries (60%). Lower limbs are the second frequent localization (28%), followed by the upper limbs (6%) and renal and mesenteric arteries (6%).^{3),13)} Cerebral embolism is usually treated medically. Arterial embolism of the extremities occurs commonly in the lower limbs constituting 50-75% of all surgical cases.²⁾ Emboli to the upper extremity is not uncommon either. Champion and Gill¹⁴⁾ collected 2,420 cases of surgical embolism and found the incidence of the upper limb

Table III. Sources of Surgical Arterial Emboli

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- I. Cardiac (90%) :
 - A. Intracardiac thrombus formation :
 1. Rheumatic valvulopathy with/without atrial fibrillation
 2. Myocardial infarction
 3. Atherosclerosis
 4. Endocarditis
 5. Thrombus on the artificial heart valves
 6. Heart failure with high end-diastolic volume
 7. Idiopathic hypertrophic subaortic stenosis
 8. Idiopathic myocardial hypertrophy
 - B. Others :
 1. Fragments of the artificial heart valves
 2. Foreign bodies
 3. Tumors (myxoma, sarcoma)
 4. Hydatidosis (echinococcosis)
 - II. Extracardiac (10%) :
 1. Pulmonary veins
 2. Aortic aneurysms and/or atherosclerosis
 3. Aortic coarctation with prestenotic thrombus
 4. Foreign bodies
 5. Extracardiac tumors eroding the blood vessels
 6. Paradoxical embolism through intracardiac defects

embolus in 15% of the patients. Review of 2,174 surgical emboli of the extremities revealed the below incidence concerning the localization of the embolus:¹⁻³⁾ upper extremity 17%, aortic bifurcation 10%, common iliac artery 15%, common femoral 43%, popliteal artery 15%. Embolus is characteristically located in the bifurcations or trifurcations of the arterial tree.

Arterial embolism is encountered more frequently in females than in males, between the fifth and seventh decades of life.²⁾ Symptoms and signs of acute arterial obstruction of the limbs are summarized as 6×P, that are " Pain, Paleness, Paresthesia, Pulselessness, Paralysis, and Prostration " as suggested by Pratt (cited by Vollmar J).²⁾

Diagnosis of peripheral arterial embolism is not difficult. Arteriography is generally not required except some cases where arteriospasm or acute arterial thrombus is suspected.²⁾

Myopathic-nephrotic-metabolic syndrome associated with bilateral acute massive arterial occlusions of the lower limbs is a serious complication, similar to the revascularization syndrome observed after the embolectomy in these severe cases, which may lead to fatal outcome. This clinical picture was first described by Haimovici in 1960.¹⁵⁾ Clinical symptoms and metabolic changes in this entity consist of edema in the limb, metabolic acidosis, hyper-

potassemia and cardiac arrhythmias, myoglobulinuria, renal shut-down, tendency for intravascular disseminated coagulation and pulmonary micro-emboli, where almost all of these pathologic changes are initiated by the metabolites released from the ischemic muscle tissue.¹⁵⁾⁻²⁰⁾

George Labey was the first who performed successful embolectomy for aortic saddle embolus in 1910. Handley was the person who understood the importance of the back-flow for a favorable prognosis (quoted by Thomas TV, Hallman GL et al).^{4), 21)} Retrograde flushing and milking were the treatments in the past. Today, the accepted treatment of choice in peripheral arterial embolism consists of the removal of the embolus with the help of Fogarty's embolectomy catheter, first introduced in 1963.²²⁾ Anticoagulation with heparine and then orally by warfarin sodium (coumadin) and infusion of low molecular weight dextran (rheomacrodex) with vasodilators are combined with the surgical therapy. Intraoperative arteriography is suggested by some authors to detect the efficiency of the embolectomy and the presence or absence of any other kind of underlying occlusive vascular disease.²¹⁾ Fasciotomy, infusion of THAM or bicarbonate, mannitol, trasylol, and sometimes peritoneal dialysis or artificial kidney are used in massive arterial occlusions and revascularization syndrome.^{16), 17), 19)} Amputation is the treatment when the gangrene has already been developed. A chance of vascular surgery is also offered to late admitted patients showing trophic, sensory and motor impairment of the limbs without gangrene to enable them to use their own extremities in lieu of prostheses, to obtain a more distal amputation and to increase the blood supply of the future stump. Same principle is also used in traumatic vascular cases in our clinic.²³⁾

Results of the surgical treatment do not depend directly on the time interval between the occurrence of the embolism and the surgical treatment, but are particularly related to the underlying disease, presence or absence of the back-flow in the extremity and the condition of the extremity at the time of the operation. For example: patients with poor cardiac functions display difficulty in maintaining the patency of their arteries after embolectomy due to the decreased cardiac output and blood flow rate.⁴⁾

Early diagnosis and treatment are necessary for a favorable prognosis. Late treatment carries high mortality and morbidity. Kristen¹³⁾ reported 85% successful results in patients operated within 6 hours following the embolism, versus 48.4% favorable results in cases operated after 6 hours following the accident.

REFERENCES

1. Saylam A, Bozer AY, Kadioglu Y.: Migration of a bullet from the inferior vena cava to the right pulmonary artery. *Jap Heart J* **13**: 572, 1972
2. Vollmar J.: *Rekonstruktive Chirurgie der Arterien*. Georg Thieme Verlag, Stuttgart, 192, 1967
3. Heberer G, Rau G, Löhr HH: *Aorta und grosse Arterien*. Springer Verlag, Berlin, 250, 1966
4. Hallman GL, Billig DM, Beall AC, Jr, Colley DA: Surgical considerations in arterial embolism. *Surg Clin North Am* **46**: 1013, 1966
5. Kawarada Y, Najmi M, Matsumoto T: A case report of arterial emboli in a male secondary to idiopathic hypertrophic subaortic stenosis. *Vasc Surg* **7**: 276, 1973
6. Crawford FA, Sethi GK, Scott SM, Takaro T: Systemic emboli due to cloth wear in a Starr-Edwards model 2320 aortic prosthesis. *Ann Thorac Surg* **16**: 614, 1973
7. Bozer AY, Hufnagel CC: Migration of a bullet from systemic vein to the right ventricle. *Acta Med Turcica* **III**: 186, 1966
8. Özer Z, Saylam A, Bozer AY: Cardiac tumors. *Ege Ü Tip Fak Mec* **10**: 529, 1971 (in Turkish)
9. Abizanda JAR, Rodriguez VC, Garcia JG, Alanis AL, Torres MCM, Bermejo MR: Embolismo coronario, periférico y visceral por mixoma de aurícula izoquiérda. Estudio clínico y anatomopatológico. *Rev Esp Cardiol* **26**: 139, 1973
10. Aletras HA: Embolism of the popliteal artery by a ruptured hydatid cyst of the heart. *Scand J Thorac Cardiovasc Surg* **1**: 188, 1967
11. Wilms H, Spillner G, Schlosser V: Seltene Ursachen peripherer arterieller Embolie. *Med Klin* **68**: 952, 1973
12. Gazzaniga AB, Dalen JE: Paradoxical embolism. Its pathophysiology and clinical recognition. *Ann Surg* **171**: 137, 1970
13. Kristen H: Zur statistischen Beurteilung der Behandlungsergebnisse beim akuten arteriellen Gefäßverschluss. *Langenbecks Arch klin Chir* **319**: 1172, 1967
14. Champion HR, Gill W: Arterial embolus to the upper limb. *Br J Surg* **60**: 505, 1973
15. Haimovici H: Arterial embolism with acute massive ischemic myopathy and myoglobulinuria. *Surgery* **47**: 739, 1960
16. Haimovici H: Myopathic-nephrotic-metabolic syndrome associated with massive acute arterial occlusions. *J Cardiovasc Surg* **14**: 589, 1973
17. Larcán A, Mathieu P, Helmer J, Fieve G: Severe metabolic changes following delayed revascularization. Legrain-Cormier syndrome. *J Cardiovasc Surg* **14**: 609, 1973
18. Milingos Sp, Tassopoulos J, Alexiou C, Yovanides C: Biochemical and coagulation changes in regional ischemia. *J Cardiovasc Surg* **14**: 619, 1973
19. Senn A, Althaus U: Revascularization syndrome after embolectomy. *J Cardiovasc Surg* **14**: 632, 1973
20. Wünniger AL: Biopathological disturbances in the revascularization stage of ischemic limbs. *J Cardiovasc Surg* **14**: 640, 1973
21. Thomas TV: Arterial embolectomy. Role of anticoagulants and arteriography. *J Cardiovasc Surg* **13**: 584, 1972
22. Fogarty TJ, Cranley JJ, Krause RJ, Strasser ES, Hafner CD: A method for extraction of arterial emboli and thrombi. *Surg Gynec Obstet* **116**: 241, 1963
23. Bozer AY, Böke E, Saylam A: Vascular injuries. An analysis of 115 cases. *J Cardiovasc Surg* **14**: 502, 1973